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THIRTEENTH PROGRESS REPORT

on

CALIBRATION AND EVALUATION OF SKYLAB ALTIMETRY FOR GEODETIC DETERMINATION OF THE GEOID (Contract NAS9-13276, EPN 440) March 1 to March 31, 1974

to

NASA Johnson Space Center
Principal Investigation Management Office
Houston, Texas 77058

from

BATTELLE
Columbus Laboratories

April 17, 1974

Prepared by: D. M. J. Fubara (Co-Investigator)

A. G. Mourad (Principal Investigator)
Z. H. Byrns, Code TF6 - NASA/JSC Technical Monitor

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PROGRESS

During this reporting period, our main effort involved

(1) Continued investigation of the effects of orbit errors in geoid determination from Skylab altimetry in particular and satellite altimetry in general.

(2) Investigation of scale and orientation control in geodetic applications of satellite altimetry. This is an outgrowth and a necessary integral part of our investigation of calibration and evaluation of Skylab altimetry for geodetic determination of the geoid. In particular, the accuracy problems of SKYBET have led us into investigation "scale and orientation control in geodetic applications of satellite altimetry".

Documents and data received and reviewed during this period are listed in Appendix A.

DATA PROCESSING RESULTS

Results of data processing and comparative analyses on scale and orientation control will be completed and reported during next period. An overview of the work involved is as follows.

Determination of the geoid in the form of heights above a reference ellipsoid is the basic step in the geodetic applications of satellite altimetry. The geoid to be determined must be in absolute position or geocentric (i.e., centered at the earth's center of mass) and have correct scale, shape and orientation in order to meet the goals of geodesy and also make contributions to the solution of problems in earth gravity modeling, geophysics, oceanography, etc. Correctness of shape depends on the precision of the altimeter and in theory, absolute centering and orientation are dependent on the satellite orbit ephemeris. The correctness of geoid scale requires that the orbit ephemeris and the altimeter either have no biases or systematic errors or such biases or systematic errors must be known to an accuracy better than the error tolerance of the geoid to be computed. Currently and for sometime to come, these two scalar conditions cannot be met because of unknown systematic errors or biases in tracking station geocentric coordinates, the earth's gravity model, the tracking systems and the altimeter itself. There is therefore, a need for other sources of scale and orientation control. Our investigation which should be completed during the next period will discuss the need for and how to use terrestrial marine geodetic data for scale and orientation control in the computation of the marine geoid, i.e., the geoid in the ocean areas from satellite altimetry.

Three types of terrestrial geodetic parameters are required for this scale and orientation control. The best available estimates of the figure of the earth in terms of the size and shape of a reference ellipsoid and geoid heights referenced to this ellipsoid are needed as a priori inputs to provide a coarse scale. Various estimates of the figure of the earth are in Mueller [1966] and Khan [1973]. The best space age estimates of the equatorial radius value range from 6,378,124 m. [Strange et, al. 1971] to 6,378,169 m. [Veis, 1967], with most estimates in 6,378,140 $\pm$ 5 m range and a flattening of 1/298·255. Unfortunately, for the geoid, agreement and/or compatibility of various authors' geoids is very discouraging [Decker, 1973 and Fubara, et.al. 1972a], particularly in the ocean areas. Vincent and Marsh [1973] geoid based on equatorial radius of 6,378,142 m. and flattening of 1/298·255 was selected for this investigation. A comparison of marine geoids of Vincent and Marsh [1973], Vincent, Strange and Marsh [1972] (see Figure 1) and Talwani, et.al. [1972] shows why the choice of any of them cannot but provide only coarse scale. The fine scale requires the use of marine geodetic control established via the use of satellite geodesy and astrogravimetric techniques [Fubara and Mourad, 1972a, 1972b and Fubara, 1973a, Mourad, et.al, 1972a and 1972b].

CONCLUSION

Based on the work completed so far, the technical conclusions are basically as given in the last progress report and also under data processing results.

As we have previously stated, we feel very strongly encouraged by current data processing results. However, analysis of the results has also identified several implicit problems. Such problems must either be resolved or effectively analyzed in order to (a) arrive at a reliable overall assessment of S-193 altimeter sensor performance evaluation, and (b) indicate the actual contributions toward future satellite altimeter design and programs for earth and ocean physics applications. The achievement of these and similar goals requires the processing and analyses of S-193 altimeter data from all other world sites besides the two test areas involved in our current task.

PROBLEMS

Problems as reported in the last progress report still exist. There are no new ones that merit reporting.

RECOMMENDATIONS

We would like to underscore the recommendations in the last two progress reports.

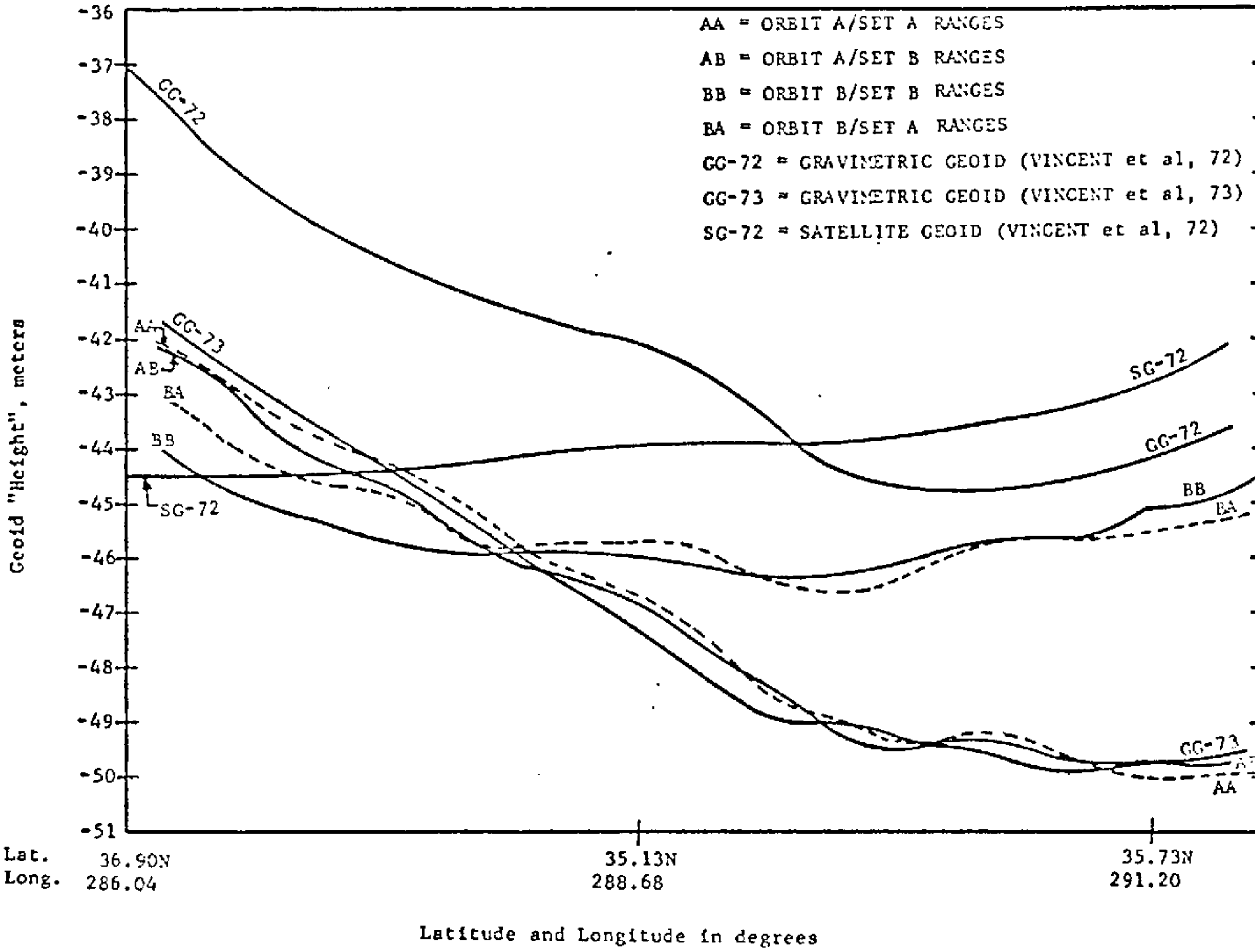

FIGURE 1. CONVENTIONAL GEOID AND SATELLITE ALTIMETRY GEOID SEGEMENTS (SKYLAB SL-2 EREP PASS 9 DATA)

NEXT PERIOD AND SUMMARY OUTLOOK

Plans for the next reporting period include

(1) Continued work on the remaining SL-2 data

(2) Continued investigation of effect of orbit errors in geoid determination from satellite altimetry

(3) Quick look examination of SL-4 data tabulations which are beginning to arrive.

(4) Completion of a formal write-up of results on scale and orientation control in geodetic apolications of satellite altimetry.

TRAVEL

No travel was undertaken in this period. During the next reporting period, travel will be made to Washington, D. C., to present, as recommended by the Technical Monitor, results reported in the last progress report. The presentation entitled "Preliminary Geodetic Processing Results of the Skylab SL-2 Altimeter Data and Potential Applications" is for a special EREP session during the annual meeting of the American Geophysical Union in Washington, D. C., April 12, 1974.

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(13) Vincent, S., Strange, W. E. and Marsh, J. G., A Detailed Gravimetric Geoid of North American, North Atlantic, Eurasia, and Australia, Paper presented at the International Symposium on Earth Gravity Models and Related Problems, St. Louis, Missouri, August, 1972.

(14) Vincent, S.and Marsh, J. G., Global Detailed Gravimetric Geoid, Computer Sciences Corporation and NASA/GSFC, Greenbelt, Md., 1973.

APPENDIX A

APPENDIX A

REPORTS AND DATA RECEIVED

Title	Identification Number	No. of Copies
SKYLAB PROGRAM Earth Resources Experiment Package Mission S/L 4 GMT Start Time: 018:20:37:13 GMT Stop Time: 018:20:50:21 Microfilm No. 34-07485	(Experiment) S190A	1